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RECOVERIES AND RESIGHTINGS OF RELEASED REHABILITATED RAPTORS

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Abstract

Our raptor rehabilitation program treated 1693 raptors between 1974–1980 and released 648. The purpose of this paper is to describe 38 recoveries or resightings of banded, color-marked or radio-tagged birds. Annual release rates (no. released/no. treated) showed a gradual increase during the period. These rates did not seem to be related to size of the patient but more to the relative severity of the injury or illness causing its admission. Release rates were lower for strigiforms (26.5%) than for falconiforms (37.2%) and a greater proportion of released strigiforms (8%) were recovered than of released falconiforms (2.4%). However, more falconiforms were recovered within 6 weeks post release (54.5% of releases vs. 21.4% for owls). On the average falconiforms were recovered over 10 times further (316.5 km) from the release site than were strigiforms (30.7 km). Length of post-release survival did not seem to be related to the severity of the original problem requiring rehabilitation. Color-marked Bald Eagles were resighted for up to 2 years after release, as far as 364 km from the release site, and two released birds were observed tending nests. Marked eagles released in wintering areas behaved similarly to other eagles already present in the area.

Introduction

In a recent survey (Duke, 1978) of holders of U.S. Fish and Wildlife Service wildlife rehabilitation permits, it was found that there are approximately 225 active raptor rehabilitation programs in the United States. These programs have a potential for handling over 7000 raptor patients per year (*Ibid.*), and, therefore, could release thousands of rehabilitated raptors annually. Only a few of these programs have been described in scientific journals (Wisecarver and Bogue, 1974; Fuller et al., 1974; Snelling, 1975; Redig and Duke, 1978) and there is little information available on the success of released, rehabilitated raptors (Servheen and English, 1976 and 1979; Olsen and Olsen, 1980).

Rehabilitation programs can perform several important functions and provide a number of worthwhile services. Rehabilitators learn to recognize, as well as to treat, many kinds of medical and surgical problems. This knowledge is of value in treating not only wildlife but also wild animals held in zoos, captive propagation programs and research projects. Information on the relative significance of common medical problems might be considered in management plans for wild populations. Perhaps most importantly, such knowledge provides direction and impetus for both basic and clinical research (e.g., Redig et al., 1980).

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Most rehabilitation programs are active in public education and those associated with colleges and universities may provide formal coursework and possibilities for graduate research projects. Rehabilitation programs provide crippled, but otherwise healthy animals for zoos, research projects, and captive propagation efforts and hold animals confiscated by law enforcement officials. Rehabilitation programs associated with public agencies or other institutions generally provide them with very positive publicity.

Lastly, wildlife rehabilitation saves lives and returns many animals to their respective breeding populations. These returns have their greatest biological significance when they involve endangered species, but saving non-endangered species is humane and provides experiences necessary to develop and maintain expertise for work on endangered species. Information on post-release success of rehabilitated birds is essential in evaluating this aspect of the significance of rehabilitation programs.

Our rehabilitation program grew out of physiological research on raptors begun in 1971. Between January 1, 1974, when we began maintaining more complete records, and December 31, 1980, 1693 raptors (Table 1) and nearly 1000 birds of other species have received care. These numbers include 144 Bald Eagles (*Haliaeetus leucocephalus*), 24 Peregrine Falcons (*Falco peregrinus*), 25 Ospreys (*Pandion haliaetus*) (Table 1) and one Whooping Crane (*Grus americana*). Most of the raptor patients we receive have been injured by humans (shooting or trapping, 32%), by accidents involving man-made obstacles (power lines, automobiles, plate-glass windows, etc., 38%), by contact with poisons, oil spills, etc. (2%), or by removal of nestlings from the nest or nest area (13%). Thus, we handle few cases involving illnesses or injuries associated with natural causes of raptor mortality and probably have little effect on natural selection pressures on raptor populations. An annual average of 37.5% of our patients die or are euthanized usually within the first 24 hours after they are received. About one-fourth (24.9%) become permanent cripples which are transferred to research or breeding programs or into zoos. The remaining proportion of our patients, approximately 38%, is released.

The objective of this paper is to describe the 38 recoveries or resightings so far obtained from the 648 raptors released by our program.

Methods

The specific procedures used in our clinical rehabilitation efforts will not be described herein because they have been described elsewhere (Fuller et al., 1974; Redig and Duke, 1978). We will, however, briefly discuss pre-release procedures.

Adults and free-flying immatures assumed to have developed hunting skills, etc. prior to admission are handled differently than birds received as nestlings. When adults are believed to have successfully recovered from injuries or illnesses they are fitted with jesses, attached to a 30 m leash and test flown. If their flight appears to be normal, daily test flights, or exercise periods, are continued until their flight is strong and they are capable of making extended flights without abnormal fatigue. Large falcons, which seem to lose physical condition more rapidly when not exercising than other falconiforms, are given more extended periods of reconditioning before release utilizing standard falconry techniques. Some birds are returned to their point of capture for release, or particularly in the case of endangered species, are transported or shipped via air freight to appropriate release points depending on the season. Most, however, are released in or near the metropolitan (Twin Cities) Minneapolis and St. Paul, Minnesota area in appropriate

Table 1. Species and total numbers of raptors treated/released per year by the University of Minnesota Raptor Research and Rehabilitation Program.

Species	1974	1975	1976	1977	1978	1979	1980	Totals**	% released
Turkey Vulture	4/1		1/0	1/0		2/1	1/0	9/2	22.2
Goshawk	4/1	5/1	6/2	4/3	2/2	4/3	5/2 (1)*	30/14	46.7
Cooper's Hawk	1/1	2/2	3/2	3/3	7/5	5/3	1/1	22/17	77.3
Sharp-sh. Hawk		4/0		10/0	5/0	4/2	3/1	26/3	11.5
Marsh Hawk		2/1	4/2	3/1	2/0		5/1 (2)	16/6	37.5
Rough-leg. Hawk	9/1	10/1	4/2	15/6	9/5	7/1	12/1 (1)	66/17	25.8
Ferrugin. Hawk			3/0	1/0	1/0			5/0	0.0
Red-tail. Hawk	28/8	36/15	41/17	54/19	56/20	46/18	51/15 (14)	312/119	38.1
Red-shoul. Hawk	2/2	1/0	2/1	3/2	3/1	2/0		13/6	46.2
Swainson's Hawk			3/1		2/1	2/0	1/1	8/3	37.5
Broad-winged Hawk	5/1	13/6	12/3	36/6	28/7	19/8	18/3 (2)	131/35	26.7
Golden Eagle	1/1	1/0	4/1	5/2	7/4	10/2	8/2	36/12	33.3
Bald Eagle	7/0	14/8	16/8	24/11	27/12	25/14	31/9 (10)	144/67	46.5
Osprey	1/0	4/0	1/0	1/0	7/1	5/0	6/1	25/2	8.0
Gyrfalcon			2/1	1/1	2/1	1/0	3/3	9/6	66.7
Prairie Falcon		5/2	3/0	14/10	7/5	6/3	2/1	37/21	56.8
Peregr. Falcon	1/0	2/1	2/0	2/2	9/1	4/2	4/2	24/8	33.3
Merlin	1/0			1/0		1/0	1/1	4/1	25.0
Amer. Kestrel	7/4	18/9	24/11	37/23	53/25	36/15	50/27 (2)	225/115	51.1
Screech Owl	4/1	11/5	14/3	11/7	14/7	21/16	14/6 (1)	89/45	50.6
Gr. Horned Owl	22/10	27/6	36/8	45/23	38/13	36/11	50/9 (14)	254/77	30.3
Long-eared Owl	2/1	4/1	1/0	9/1	7/0	4/0	5/4	32/7	21.9
Short-eared Owl	2/0	4/0	1/0		9/1	4/1	2/0	22/2	9.1
Snowy Owl	3/0	6/1	4/1	4/2	3/2	5/1	18/1 (9)	43/12	27.9
Barred Owl	1/0	4/0	13/4	19/8	15/4	14/6	12/2 (3)	78/25	32.1
Great Gray Owl	1/0				3/0	2/1	1/0	7/1	14.3
Burrowing Owl		1/0						1/0	0.0
Boreal Owl				1/0				1/0	0.0
Saw-whet Owl		2/0	3/0	4/2	5/1	4/2	6/1 (1)	24/6	25.0
Totals**	106/41	176/59	203/67	308/132	321/118	269/110	310/121	1693/648	
Release rate	38.7	33.5	33.0	42.9	36.8	40.9	39.0		

*Numbers in parentheses indicate cases whose outcome is pending at the time of this writing.
**Total released includes one-half of those pending since this generally represents the outcome of pending cases.

habitat. The Twin Cities Arsenal Compound has been a common release site (Tables 2 and 3). It has an area of approximately 1340 ha, it has little human activity, it is largely undeveloped, and it is on the northern edge of the metropolitan area so it serves as a large refuge and an ideal release area.

Orphans or nestlings, without an illness or injury which are brought to our clinic are returned to their own nest or to a foster nest as soon as possible. Injured nestlings, or immatures believed to have had insufficient time to have developed adequate hunting skills, are "hacked" by standard procedures after a reconditioning program. Hacking has usually been handled by experienced falconers or biologists at refuges, nature centers or isolated rural areas.

All released birds were banded with U.S. Fish and Wildlife Service bands of appropriate sizes under the permit of one of the authors (W. Jones). Bald Eagles were banded and also color-marked or tagged with patagial or leg-band streamers by Dr. L. D. Frenzel of the Entomology, Fisheries and Wildlife Department, University of Minnesota, St. Paul, MN 55108. Four Bald Eagles were radio-tagged, released in wintering areas commonly used by eagles near Moline, IL, and subsequently observed and radiotracked by Dr. T. C. Dunstan and his graduate students of the Department of Biological Sciences, Western Illinois University, Macomb, IL 61455.

For purposes of evaluating the success or failure of released rehabilitated raptors described in this study, we considered 6 weeks of survival to be a minimum standard of success. Red-tailed Hawks (*Buteo jamaicensis*) die of starvation in 2-3 weeks without food (Dobbs, 1980). Presumably smaller birds would succumb more rapidly. Thus, 6 weeks survival indicates that a released bird has at least acquired the ability to forage and feed itself.

Results and Discussion

Our average annual release rate for all species (number released/number treated) appears to be better in the period 1977–80 than prior to that period (Table 1); we hope this is indicative of increased clinical skills and improved success in rehabilitation. The recent release rate is similar to those reported by Snelling (1975) (39.6%) and Wisecarver and Bogue (1974) (47%).

Size of the patient did not seem to be a factor in determining the success of rehabilitation or the average annual proportion of releases. Release rates for the smaller owls (*viz.* Screech Owl, *Otus asio;* Long-eared Owl, *Asio otus;* Short-eared Owl, *Asio flammeus;* Saw-whet Owl, *Aegolius acadicus*) excluding the Burrowing Owl (*Speotyto cunicularia*) and Boreal Owl (*Aegolius funereus*) because we've handled only one of each (Table 1), averaged 26.7% per year. For the larger owls (Great Horned Owl, *Bubo virginianus;* Snowy Owl, *Nyctea scandiaca;* Barred Owl, *Strix varia;* Great Gray Owl, *Strix nebulosa*) the mean rate was 26.2%. The average release rate for the smaller falconiforms (Cooper's Hawk, *Accipiter cooperii;* Sharp-shinned Hawk, *Accipiter striatus,* Red-shouldered Hawk, *Buteo lineatus;* Broad-winged Hawk, *Buteo platypterus;* Merlin, *Falco columbarius;* American Kestrel, *Falco sparverius*) was 39.6% and for the larger ones (Turkey Vulture, *Cathartes aura;* Goshawk, *Accipiter gentilis;* Marsh Hawk, *Circus cyaneus;* Rough-legged Hawk, *Buteo lagopus;* Ferruginous Hawk, *Buteo regalis;* Red-tailed Hawk; Swainson's Hawk, *Buteo swainsoni;* Golden Eagle, *Aquila chrysaetos;* Bald Eagle; Osprey; Gyrfalcon, *Falco rusticolus;* Prairie Falcon, *Falco mexicanus;* Peregrine Falcon) (Table 1) it was 34.8%. The average annual release rate for Bald Eagles, 46.5%,

Table 2. Recoveries and Recaptures of Released Rehabilitated Strigiforms.

Species	Original Problem	Release data date	Release data site	Recovery data date	Recovery data site	Elapsed time (days)	Reason for recov.**
Gr. Horned Owl	Trap, foot amput.	mid 1/75*	T.C. Arsenal	mid 4/75	T.C.,1.7 Km,W.	ca. 120	Alive, wing fx, emac.
Gr. Horned Owl	Coll., auto, concussion	11/8/75	”	11/14/76	T.C.,21.7 Km,S.	371	Dead, Coll. power line
Gr. Horned Owl	Proj., both wing fx.	2/5/77	Is Lake Park St. Paul	2/20/77	T.C.,1.7 Km,N.E.	15	Alive, but emac., died
Gr. Horned Owl	Proj., wing fx	2/16/77	T.C. Arsenal	3/10/78	T.C.,6.7 Km,S.	387	Dead, Coll.? by R.R.
Gr. Horned Owl	Coll., auto, wing fx	3/7/77	T.C. Arsenal	3/22/80	81.8 Km,N.W.	1110	Dead, unk. cause
Gr. Horned Owl	Intes. parasites	6/8/77	T.C. Arsenal	10/77	71.8 Km,N.W.	ca. 120	Dead, proj.
Gr. Horned Owl	Eye inflamm., emac. from skunk	9/16/77	T.C. Arsenal	10/8/77	T.C.,1.7 Km,E.	22	Caught by hand. released
Gr. Horned Owl	Trap, foot injury	2/11/78	T.C. Arsenal	3/9/79	T.C.,8.4 Km,N.W.	391	Alive, leg fx, emac.
Gr. Horned Owl	Concussion	11/15/77	T.C. Arsenal	8/5/79	33.4 Km,N.W.	623	Caught in mamm. trap
Gr. Horned Owl	Kite string entangled	12/30/78	Is Lake Park St. Paul	mid 4/79	T.C.,4.2 Km,S.	ca. 106	Dead, unk. cause
Barred Owl	Nestling; (hacked)	9/4/76	Winona, MN	1/1/77	T.C.,178.7 Km,N.W.	87	Dead, unk. cause
Barred Owl	Nestling; (hacked)	early 6/78	Fridley, MN Nat. Center	4/3/79	T.C.,1.7 Km,S.	ca. 130	Found in warehouse; released
Barred Owl	Nestling; (hacked)	early 6/78	Fridley, MN Nat. Center	2/24/80	T.C.,15.9 Km,N.W.	ca. 620	Dead, Coll., auto
Screech Owl	Trap, leg fx	9/21/78	Como Park St. Paul	11/3/78	T.C.,1.7 Km,W.	14	Dead, emac.

*Often those recovering and releasing birds do not record exact dates.
**Dead birds found in reasonably fresh condition.

Proj. = projectile injury; Coll. = collision injury; fx = fracture; T.C.—Twin Cities area; Trap = steel-jawed trap; emac. = emaciated

Table 3. Recoveries and Recaptures of Released Rehabilitated Falconiforms.

Species	Original Problem	Release data date	Release data site	Recovery data date	Recovery data site	Elapsed time (days)	Reason for recov.**
Red-tail. Hawk	Proj., wing fx	1/3/76	T.C. Arsenal	3/20/76	T.C.,5 Km,E.	ca. 17	Alive but emac., died
Red-tail. Hawk	Coll., wing fx	2/26/77	T.C. Arsenal	4/25/77	T.C.,3.3 Km,S.	58	Alive but emac., died
Red-tail. Hawk	Undet. illness	10/31/78	T.C. Arsenal	3/29/79	Wyoming, IA, 330 Km,S.	149	Dead; unk. cause
Red-tail. Hawk	Proj., wing & leg fx	2/23/79	Anoka, MN	4/17/79	T.C.,18.4 Km,S.E.	53	Dead; unk. cause
Rough-legged Hawk	Trap, foot amput.	10/30/77	T.C. Arsenal	2/10/78	Jeff. City, MO 943.6 Km,S.	103	Dead; unk. cause
Rough-legged Hawk	Coll., auto wing & leg fx	3/4/79	T.C. Arsenal	mid 11/79*	No. Quebec, approx. 1625 Km,N.E.	ca. 255	Dead; in fox snare
Broad-winged Hawk	Coll., auto stunned	9/6/80	T.C. Arsenal	9/17/80	T.C.,14.2 Km,W.	11	Dead; Coll., auto (30 g wt gain)
Broad-winged Hawk	Proj., wing fx	9/73	Anoka MN airport	10/73	T.C.,14.2 Km,S.W.	ca. 35	Dead; Coll., auto
Bald Eagle	Proj., wing fx	11/29/77	Prescott, WI	12/20/77	Rochester, MN 90.2 Km,S.W.	21	Alive; proj. wing fx
Bald Eagle	Proj., wing fix	mid 9/75	Montezuma Refuge, NY	late 10/75	50 Km,N.W.	ca. 40	Dead, Barb-wire entangled
Bald Eagle	Proj., wing fx	1/24/77	Swan Lake Refuge MO	1/31/77	Swan Lake Refuge	7	Alive, weak, recaptured, released

*Often those recovering and releasing birds do not record exact dates.
**Dead birds found in reasonably fresh condition.

Proj. = projectile injury; Coll. = collision injury; fx = fracture; T.C.—Twin Cities area; Trap = steel-jawed trap; emac. = emaciated

was higher than the mean for all falconiforms together but was not the highest release rate (Table 1) for individual species. A relatively higher rate might have been expected because eagles are large and somewhat easier to repair surgically. Also, endangered species are shipped to us via air freight so receive relatively more rapid attention to their injuries and receive "V.I.P." treatment while under our care.

Averages for release rate for certain species may be distorted upward or downward by a problem or situation peculiar to that species. Among the small species most commonly admitted for our care are Kestrels and Screech Owls. Both of these species have high average annual release rates (Table 1) due primarily to the large number of nestlings of these species received each year. They may be hacked-out with little or no medical attention, allowing a high release rate. Red-tailed Hawks, Great Horned Owls, and Bald Eagles are the commonest of the large species we handle. All three, but particularly the latter two species, seem to be prone to injury in mammal traps. Analysis of our records indicates that mortality is higher in trapped raptors than for raptors receiving any other type of injury. Additionally, trapping injuries invariably result in loss of toes, feet, or an entire limb so that victims may not be releasable. Death or loss of limbs both reduce release rates. Therefore, while release rates do reflect a measure of success (or lack of success) in rehabilitation, they do not necessarily directly reflect a level of expertise in medicine or in surgical repair, i.e., such rates may be obtained by hacking procedures requiring little or no surgical or medical expertise.

As indicated above, average annual release rates for strigiforms are lower than those for falconiforms. In our experience, owls in general are no better or poorer risks for rehabilitation than falconiforms. The poorer release rate of owls is probably due to their being admitted with more serious medical problems (e.g., trapping), and thus, problems more difficult to handle.

Using our criterion for success of 6 weeks survival post-release, only 21.4% of recovered owls were recovered within 6 weeks after release (Table 2). Over half (54.5%) of the recovered falconiforms were recovered within 6 weeks postrelease (Table 3). This should not, however, be interpreted as a greater success at rehabilitating owls than hawks nor as indication that rehabilitated owls are more likely to survive than hawks since an overall greater proportion of released owls (14 birds or 8% of those released) were recovered than of released falconiforms (11 birds or 2.4% of those released) (Tables 1, 2, and 3). We can't be sure of the reasons for this differential post release success. The falconiforms listed in Table 3 are likely to inhabit open or aquatic (Bald Eagles) areas, except for Broad-wings, so ought to be more easily found if dead or dying than the owls (Table 2) all of which tend to be more secretive and to inhabit more forested areas where visibility is limited. So, there may be no difference in post release success, but rather a difference in the likelihood of finding dead or dying owls vs. hawks.

The proportion of recoveries per released rehabilitated raptor (8 and 2.4% for falconiforms and strigiforms, respectively) may be higher for our project than in other projects. Snelling (1975), who banded and released 53 raptors, had one recovery, viz. a Red-tailed Hawk found 3 weeks post release at 5 km from the release site with a rebroken leg fracture. Wisecarver and Bogue (1974) released 76 raptors and had no recoveries. Our high recovery rate is hopefully mainly a result of the fact that most birds were released near a large human population center thus increasing the likelihood of dead or dying birds being discovered.

Length of post release survival does not seem to be related to the severity of the injury or illness requiring the original admission to our clinic. One of the two Great Horned Owls recovered in less than 6 weeks after release (Table 2) was admitted with fractures of both wings—an extremely serious problem. However, the other bird was admitted with an eye inflammation and emaciation—not nearly as serious nor requiring as long a period of treatment. Five of the six falconiforms recovered in less than 6 weeks after release had wing fractures when originally admitted for rehabilitation. Even slightly improper wing function after release could easily be cause for poor survivability. Again, however, one of the shortest survival times was recorded for the sixth recovered falconiform, a Broad-winged Hawk admitted with only a mild concussion (Table 3).

The data (Tables 2 and 3) indicate a higher proportion of recoveries from releases in 1974–1977 than from releases in 1978–1980 (16 vs. 9). This difference may indicate less medical expertise during the earlier period. It is more likely, however, an indication that longevity in released rehabilitated raptors is approximately equal to that in raptors not having experienced rehabilitation, i.e., most raptors, whether released following rehabilitation or naturally fledged during the period 1974–1977, probably would be expected to be dead, and thus recoverable, by 1980. A smaller proportion of birds released in 1978–1980 would be expected to have died from natural causes by the end of 1980.

Recovery data indicate, that, on the average, owls were recovered only 30.7 km from their point of release (Table 2) while falconiforms traveled more than 10 times farther, or 316.5 km on the average, between the release site and the point of their recovery (Table 3). However, hawks released during migration times moved, on the average, 496 km while those released during non-migration times moved only 23.4 km. So, this difference occurred because many species of hawks are migratory and many releases were during a migratory season.

No hacked hawks were recovered while three hacked Barred Owls were recovered from 87–620 days post release (Table 2). This difference is probably not significant relative to success of hacked hawks vs. owls and we have no explanation for it. Confirmation of success of a released nestling Barn Owl (*Tyto alba*) is provided by Marti and Wagner (1980) who discovered the owl nesting about 1 year after it and seven others had been placed in foster nests. The owl was found 60 km from the foster nest.

Color-marked Bald Eagles were resighted up to 2 years after release and as far as 364 km from the release site (Table 4). One-half of the resightings occurred within 2 weeks post-release so provide little information on post release survival. However, the other half of the resightings occurred from about 6 months to 2 years post-release and included two birds involved in nesting and raising young (Table 4). We feel that this resighting information, particularly that pertaining to the two birds observed tending nests, is excellent evidence of the value of rehabilitation.

The radiotracked Bald Eagles (Table 4) were also visually observed intensively on the wintering area. Their behavior, with respect to other wintering eagles, appeared to be normal with the exception of the one-footed bird. The latter tended to roost alone and to avoid conflicts over food (mostly waterfowl carcasses) although it did appear to find sufficient food and it remained healthy in appearance. Further observations of these radiotracked birds and of several others currently under observation will be reported in more detail elsewhere.

Servheen and English (1976 and 1979) also released rehabilitated color-marked and

Table 4. Resightings of Released Rehabilitated Color-Marked Eagles.

Species	Original Problem	Release data date	Release data site	Recovery data date	Recovery data site	Elapsed time (days)	How resighted
Golden Eagle	Eye infect., emac.	4/29/76	Prescott, WI	5/1/76	3.3 Km,S. Prescott	2	Observed markings
Golden Eagle	Proj., wing fx	12/14/77	Prescott, WI	11/18/78	Bl.R.Falls,WI 175.4 Km,N.E.	339	Observed markings
Bald Eagle	Trap, toes injured	12/28/73	Prescott, WI	6/74*	Nesting; Prentice, WI,240.5 Km,N.E.	ca. 170	Observed markings
Bald Eagle	Healthy orphan	8/75	into a nest; Sherborne Refuge, MN	same day	100.2 Km,S.		Observed markings
Bald Eagle	Inj. in eagle fight	3/9/76	Prescott, WI	6/78	Nesting; Harris, MN, 101.9 Km, N.W.	ca. 740	Observed markings
Bald Eagle	Proj., wing fx	9/4/76	Duluth, MN	9/5/76	5 Km,N. Duluth	1	Observed markings
Bald Eagle	Trap, toes inj.	12/14/77	Prescott, WI	11/78	Det. Lakes, MN 364.1 Km,N.W.	ca. 340	Observed markings
Bald Eagle	Healthy orphan	7/1/78	into a nest, Drummond, WI	7/6/78	seen near nest	5	Observed markings
Bald Eagle	Nestling, leg fx	7/15/78	into a nest, Minong, WI	7/28/78	seen near nest (fledged)	13	Observed markings
Bald Eagle	Crop perforation	mid 2/80	Moline, IL (radio)	6/11,18/80	St Croix Falls Pk, WI, 666.3 Km, N.	ca. 120	Radio tracked, seen
Bald Eagle	Coll., wing fx	4/27/80	Moline, IL (radio)	6/11,18/80	St Croix Falls Pk, WI, 666.3 Km, N.	51	Radio tracked, seen
Bald Eagle	Trap**	mid 2/80	Moline, IL (radio)	3/11/80	flying N from Moline, lost	ca. 25	Radio tracked, seen
Bald Eagle	Trap, toes inj.	mid 2/80	Moline, IL (radio)	immed. flew away, radio signal lost			

*Often those recovering and releasing birds do not record exact dates.
**Bird had only 1 foot, stump had received a 2nd trap injury when presented.

Proj. = projectile injury; Coll. = collision injury; fx = fracture; T.C.—Twin Cities area; Trap = steel-jawed trap; emac. = emaciated

radio-tagged Bald Eagles. Six birds released between 1972–1975 were observed or monitored from 6–83 days on the wintering area and were detected as far as 108.6 km from the release site. Birds which could be observed at the release site appeared to remain healthy and behaved similarly to wild birds at the release site. Eleven other eagles released on a wintering area between 1975–1978 remained in the area up to 45 days, also appeared to behave normally and were believed to have dispersed from the area at the same time and in the same general direction as the wild eagles. A total of 37 sightings was reported on these birds, one at 332 km from the release site. The availability of color-marked eagles provided valuable information on wintering and dispersal behavior as well as information on survival of released rehabilitated eagles.

Matters that might be considered in releasing rehabilitated or captive raptors have been offered by several authors. Snyder and Snyder (1974) found that mortality due to encounters with humans was greater in Cooper's Hawks which were closely observed as nestlings and/or weighed and handled, than in Cooper's Hawks with little exposure to man. This would indicate that captivity and the procedures necessary for rehabilitation might increase the vulnerability of rehabilitated birds upon release. We feel that this may be a greater problem in nestlings brought into captivity for rehabilitation than in adults since adults appear to associate humans with danger while nestlings usually do not. We return nestlings to their own or to foster nests as rapidly as possible to avoid undue tameness or imprinting on humans. However, while we make no effort to tame either nestlings or adults in our care, we know of no way of offering treatment without handling and exposure to humans.

Olsen and Olsen (1980) report that the release of a Wedge-tailed Eagle (*Aquila andax*) (previously held in a zoo and apparently not imprinted) failed because of the bird's aggressiveness towards humans and discussed the possibility that raptors be taught to fear humans before release. Again, we would expect a fear of humans to be normal in adult raptors with little or no previous exposure to man and we would object to most procedures producing outright fear of humans from patients in our care. We agree with Cooper and Gibson (1980) who describe medical and behavioral considerations important in evaluating a patient's preparedness for release, in that birds which are too tame or too imprinted to be expected to survive successfully after release should not be released. These birds can be turned over to captive propagation or research programs or to zoos or possibly hacked in very remote areas by experienced individuals. Even after such hacking some birds may still seek humans and injure them or be injured by them. On the other hand, despite the poorest of release conditions or pre-release considerations some birds may still do quite well. Marti and Wagner (1980) describe the case of a tame, Barn Owl, imprinted on humans, which escaped from an aviary and was found nesting 6 months later. This is remarkable, both that the bird survived without prior hunting experience and that she paired with an owl after imprinting on humans.

We have calculated the 1980 cost of raptor rehabilitation for our program, including all medications, x-rays, surgical costs, and nursing and veterinary salaries, to be $313.00 per bird released; considering only our most common endangered patient, the cost is $3885.00 per Bald Eagle released. Rehabilitation may be therefore, a relatively inexpensive management technique considering the cost per individual of translocations and captive propagation, which result in releases of fledglings several years away from breeding age, or even of habitat manipulation or nest protection for endangered species.

In conclusion, we believe that raptor rehabilitation is worthwhile even if it only helps

in learning to recognize medical problems in wild raptors, or even if it only helps to educate the public as to the value of birds of prey, or even if it only provides subjects for research and captive propagation efforts. However, as our data indicate, many rehabilitated birds are released, and recovery data indicate that many may sustain approximately normal longevity. Released birds may, as proven by observations of color-marked Bald Eagles, contribute to wild populations via reproduction.

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RAPTOR REHABILITATION WORKSHOP OFFERED

The Indianapolis Zoo is sponsoring a Raptor Medicine and Rehabilitation Workshop on April 24, 1982 from 9 a.m. to 6 p.m. Dr. Pat Redig of the College of Veterinary Medicine, University of Minnesota, will be the speaker. The workshop will include diagnostic procedures, anesthesia, surgery, medicine and more. The registration fee of $25.00 includes lunch; the registration deadline is April 19, 1982. For further information, please write to Indianapolis Zoo, Education Dept., 3120 E. 30th Street, Indianapolis, IN 46218.

THE INCIDENCE OF MAN-CAUSED AND NATURAL MORTALITIES TO RAPTORS

by
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Introduction

Over the past 15 years, I have observed more than a hundred cases of raptor mortality, most of which were man caused either directly or indirectly. These observations stimulated me to examine additional data from other sources concerning raptor mortality. This paper, the result of looking into raptor mortality factors, discusses the incidence of man-caused and natural mortalities. Data is also provided on frequency of band returns, maximum recorded longevity, and average survival for 24 raptor species.

Methods

In 1976, I developed a questionnaire which I mailed to 40 people to gather data about mortality and instances that they were aware of. Replies were received concerning 153 cases of mortality from 16 persons. My records from 1969 to present contained 120 cases. I also contacted the Raptor Rehabilitation Center (RRC) at the University of Minnesota, and they provided 1,051 additional records. The Federal Bird Banding Laboratory (BBL) in Laurel, Maryland, provided 5,697 records of mortality for raptors banded in North America.

Results and Discussion

I have treated the data in several ways. Table 1 indicates the species included in this study and the information available as the number of returns for raptors banded in North America between 1955 and 1979. The average band return for birds of prey as a group runs 1.7%. Returns from two Canadian banders are not included. Average survival was calculated by using birds banded as nestlings and recovered at a later date (Table 2). Four species have no survival information as nestling data was not available.

Overall, the Red-tailed Hawk (*Buteo jamaicensis*), Great Horned Owl (*Bubo virginianus*), and American Kestrel (*Falco sparverius*) provided for 43.2% of the mortality records. These three species are common and widely distributed in North America and utilize similar habitat types.

Tables 3, 4, and 5 present data for the three data groups (Keran and others, RRC, and BBL) regarding causes of mortality for each species. Table 4 lists all birds as mortalities when, in fact, some (approximately 30% overall) were successfully rehabilitated. I feel justified in calling the rehabilitated birds mortalities—because, had the RRC not been in existence, the birds would not have survived.

Table 6 indicates the percent of all reported records for raptor mortality and lists mortalities as to type (natural, man caused, and unknown).

Natural causes accounted for 9.6% (Keran and others), 7.9% (RRC), and 6.9% (BBL) of reported mortalities. Man-caused deaths accounted for 85.4% (Keran and others), 83.8% (RRC), and 25.7% (BBL) of the mortalities. Unknown causes were 4% (Keran and others), 8.3% (RRC), 67.4% (BBL) of the reported deaths. Records from the Bird Banding

Table 1. Birds of Prey Band Returns for 1955-1979

Species	No. banded 1955–August 1979	No. returns 1955–August 1979	% returns
Osprey	10,747	284	2.6
Goshawk	5,388	122	2.3
Cooper's Hawk	6,935	106	1.5
Sharp-shinned Hawk	78,616	473	0.6
Red-tailed Hawk	37,908	962	2.5
Red-shouldered Hawk	4,072	71	1.7
Swainson's Hawk	4,496	50	1.1
Broad-winged Hawk	2,746	34	1.2
Am. Rough-legged Hawk	1,524	41	2.7
Harrier	5,158	73	1.4
Golden Eagle	2,866	120	4.2
Bald Eagle	4,248	136	3.2
Merlin	3,873	31	0.8
Kestrel	54,296	910	1.7
Barn Owl	8,046	364	4.5
Great Horned Owl	12,999	493	3.8
Barred Owl	973	35	3.6
Long-eared Owl	3,641	22	0.6
Short-eared Owl	1,690	18	1.1
Screech Owl	9,213	218	2.4
Saw-whet Owl	12,003	72	0.6
Snowy Owl	1,115	50	4.5
Great Gray Owl	220	6	2.7
Boreal Owl	270	3	1.1

Table 2. Longevity and Survival for Birds of Prey from Bird Banding Laboratory Records

Species	No. of Records	Longevity yr.	Longevity mo.	Average Survival (mo.)
Osprey	447	21	10	35.8
Goshawk	120	8	7	10.7
Cooper's Hawk	136	6	5	16.3
Sharp-shinned Hawk	484	13	0	—
Red-tailed Hawk	1,031	21	1	16.1
Red-shouldered Hawk	104	11	10	25.6
Swainson's Hawk	54	5	2	15.8
Broad-winged Hawk	37	3	2	12.0
Am. Rough-legged Hawk	48	18	1	20.7
Harrier	114	10	8	16.6
Golden Eagle	130	11	1	19.6
Bald Eagle	173	27	1	18.8
Merlin	35	3	5	14.3
Kestrel	1,017	9	10	12.6
Barn Owl	572	34	0	20.9
Great Horned Owl	525	17	5	29.3
Barred Owl	50	10	6	25.5
Long-eared Owl	36	13	7	3.4
Short-eared Owl	21	2	6	1.0
Screech Owl	410	27	10	10.6
Saw-whet Owl	89	3	8	—
Snowy Owl	55	5	9	—
Great Gray Owl	6	1	8	5.5
Boreal Owl	3	1	10	—

Laboratory are too general for any in-depth assessment of mortality; however, data from the RRC and my questionnaires may give a more accurate picture as to the incidence of various mortality factors in the Great Lakes area. From my own observations as well as those of others, roads appear to play an important role in discovered raptor deaths (Table 3). I was informed by Dr. Pat Redig (pers. comm.) from RRC that the most frequent causes of accidents (Table 4) are moving vehicles.

Table 3. Bird-of-Prey Mortality Records (273) as Reported by DK and Others

	Number	Natural		Man Caused				
Species	# Recorded	Predator Kill	Other	Road Kill	Trap	Shot	Other	Unknown
Osprey	1	—	—	—	—	1	—	—
Goshawk	14	—	3	1	4	4	2	—
Cooper's Hawk	11	2	—	—	4	3	2	—
Sharp-shinned Hawk	11	—	—	5	—	1	5	—
Red-tailed Hawk	34	1	—	9	8	12	3	1
Red-shouldered Hawk	7	—	—	1	1	3	2	—
Swainson's Hawk	1	—	—	1	—	—	—	—
Broad-winged Hawk	35	5	—	27	—	2	—	1
Am. Rough-legged Hawk	2	—	—	1	1	—	—	—
Harrier	0	—	—	—	—	—	—	—
Golden Eagle	1	—	1	—	—	—	—	—
Bald Eagle	10	—	1	1	1	7	—	—
Merlin	4	—	—	1	—	2	1	—
Kestrel	12	—	—	12	—	—	—	—
Barn Owl	5	—	5	—	—	—	—	—
Great Horned Owl	50	—	3	12	20	8	3	4
Barred Owl	25	—	1	19	—	5	—	—
Long-eared Owl	6	—	—	6	—	—	—	—
Short-eared Owl	5	—	—	1	—	—	4	—
Screech Owl	11	—	—	8	1	1	1	—
Saw-whet Owl	14	2	1	7	—	—	1	3
Snowy Owl	6	—	—	1	2	1	—	2
Great Gray Owl	4	—	1	2	—	1	—	—
Boreal Owl	1	—	—	1	—	—	—	—

In conclusion, data from banding records may be too general for drawing any in-depth conclusions about raptor mortalities. However, they do provide some indication as to expected band return frequencies and raptor longevity. Other sources of information indicate that man plays an important role in mortality of raptors, especially from vehicular collisions. Birds killed along roadways are obviously detected more often by man than birds killed away from roads, and, before an accurate assessment of the incidence of mortality causes can be made, a study should be done to determine the incidence of mortalities that usually go undetected by man.

Table 4. Bird-of-Prey Mortality Records (1,051) as Reported by Raptor Rehabilitation Laboratory, U of M. (RRC) 1974-1979

Species	Number Recorded	Natural: Predator Kill	Natural: Other	Man Caused: Road Kill	Man Caused: Trap	Man Caused: Shot	Man Caused: Other	Unknown
Osprey	14	—	1	—	0	6	7	0
Goshawk	21	—	10	—	1	5	3	2
Cooper's Hawk	16	—	8	—	1	0	6	1
Sharp-shinned Hawk	19	—	0	—	0	3	16	0
Red-tailed Hawk	213	—	23	—	18	63	85	24
Red-shouldered Hawk	12	—	2	—	1	0	8	1
Swainson's Hawk	5	—	0	—	0	4	1	0
Broad-winged Hawk	94	—	6	—	1	24	61	2
Am. Rough-legged Hawk	47	—	0	—	8	16	23	0
Harrier	11	—	0	—	1	3	7	0
Golden Eagle	18	—	2	—	3	9	4	0
Bald Eagle	88	—	9	—	13	28	25	13
Merlin	2	—	0	—	0	2	0	0
Kestrel	139	—	2	—	1	6	115	15
Barn Owl	0	—	0	—	0	0	0	0
Great Horned Owl	168	—	10	—	37	23	85	13
Barred Owl	52	—	4	—	5	7	31	5
Long-eared Owl	23	—	1	—	0	4	15	3
Short-eared Owl	16	—	0	—	1	2	12	1
Screech Owl	54	—	3	—	1	4	40	6
Saw-whet Owl	14	—	0	—	0	1	12	1
Snowy Owl	20	—	2	—	1	9	8	0
Great Gray Owl	4	—	0	—	0	2	2	0
Boreal Owl	1	—	0	—	0	0	1	0

Table 5. Bird-of-Prey Mortality Records (5,697) as Reported by the Bird Banding Laboratory (BBL) Through August 1979

Species	Number Recorded	Natural: Predator Kill	Natural: Other	Man Caused: Road Kill	Man Caused: Trap	Man Caused: Shot	Man Caused: Other	Unknown
Osprey	447	5	36	8	0	0	83	315
Goshawk	120	1	3	8	0	0	15	93
Cooper's Hawk	136	1	5	8	0	0	15	107
Sharp-shinned Hawk	484	11	9	22	0	0	137	305
Red-tailed Hawk	1031	7	65	147	0	0	59	753
Red-shouldered Hawk	104	1	4	19	0	0	4	76
Swainson's Hawk	54	3	0	13	0	0	4	34
Broad-winged Hawk	37	0	1	9	0	0	2	25
Am. Rough-legged Hawk	48	0	2	14	0	0	2	30
Harrier	114	2	9	3	0	0	7	93
Golden Eagle	130	0	10	9	0	0	19	92
Bald Eagle	173	0	14	7	0	0	16	136
Merlin	35	2	0	6	0	0	2	25
Kestrel	1017	29	58	158	0	0	186	586
Barn Owl	572	5	24	88	0	0	71	384
Great Horned Owl	525	6	24	97	0	0	63	345
Barred Owl	50	1	3	11	0	0	2	33
Long-eared Owl	36	0	2	2	0	0	2	30
Short-eared Owl	21	0	1	6	0	0	1	13
Screech Owl	410	10	23	89	0	0	23	35
Saw-whet Owl	89	2	0	13	0	0	5	36
Snowy Owl	55	0	4	8	0	0	2	41
Great Gray Owl	6	0	0	3	0	0	1	2
Boreal Owl	3	0	1	0	0	0	0	2

Table 6. Percent of 7,021 Records by Major Mortality Factors

Cause of Mortality	Keran and Others (273)	Raptor Rehab Lab (1051)	Banding Lab (5697)
Natural Causes			
Predator kill	3.7	–	1.5
Other	5.9	7.9	5.2
Man Caused			
Road kill	42.5	–	13.1
Trap	15.4	8.8	–
Shot	18.7	21.0	–
Other	8.8	54.0*	12.7
Unknown	4.0	8.3	67.4

*This includes some accidents that are vehicular in nature.

I wish to thank the following people for furnishing their mortality records:
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Brad Maas–Western Minnesota
Ed Pratt–Central Minnesota and Nevada
Fran Hamerstrom–Central Wisconsin
Mark Fuller–Central Minnesota
Gerald Niemi–Northeastern Minnesota
Karl Siderits–Northeastern Minnesota
John Mathisen–North central Minnesota
Bill Irvine–Northeastern and west central Michigan
Bill Taylor–Upper Peninsula of Michigan
Larry Martoglio–Northeastern Wisconsin
Jim Malone–Central Minnesota
Stan Temple–New York and central Canada
Dan Frenzel–North central Minnesota

A SURVEY OF WINTERING BALD EAGLES IN SOUTHEASTERN MONTANA

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Abstract

About 78 Bald Eagles (*Haliaeetus leucocephalus*) wintered on 71,500 km^2 in southeastern Montana each winter during the winters of 1976–77, 1977–78, and 1978–79. Most (71%) wintered on major rivers, some (22%) were associated with upland/riparian areas, and a few (8%) wintered strictly on upland sites. Upland wintering by Bald Eagles appears to be more common in the central portion of their winter range on the Great Plains and less common at the northern and southern edges of that range, perhaps due to greater competition for riparian wintering areas in the central Great Plains where wintering Bald Eagles apparently occur at greater densities.

Introduction

Bald Eagles winter in "fairly large numbers" on the dry plains and semidesert valleys of the western United States (Murphy 1977:60). Censuses of Bald Eagles in Colorado, Wyoming, and Utah show that substantial numbers winter on upland habitats (Enderson

et al. 1970, Wrakestraw 1973, Platt 1976, Spencer 1976, Woffinden and Murphy 1977). However, few data are available on the wintering Bald Eagles in southeastern Montana. Here we present data on the distribution and use of uplands by wintering Bald Eagles in southeastern Montana at the northern edge of the species' winter range on the Great Plains (Steenhof 1978).

Study Area

The study area encompassed about 88,000 km^2 in southeastern Montana south of the Missouri River and east of the Musselshell and Bighorn Rivers excluding the Crow and Northern Cheyenne Indian Reservations (Fig. 1). It is dominated by big sagebrush (*Artemisia tridentata*) steppe, but some grass-dominated steppes, ponderosa pine (*Pinus ponderosa*) forests, and ponderosa pine savannas are present. Plains cottonwood (*Populus deltoides*) predominates along larger rivers and is scattered along most major creeks. The area lies almost entirely within the unglaciated sedimentary plains, except for a small glaciated area between the Yellowstone and Missouri Rivers near North Dakota. Topography varies from almost flat to rough "breaks" and high hills, but it is mostly rolling. Elevation varies from 600 to 1360 m. The climate is continental and semiarid, with hot

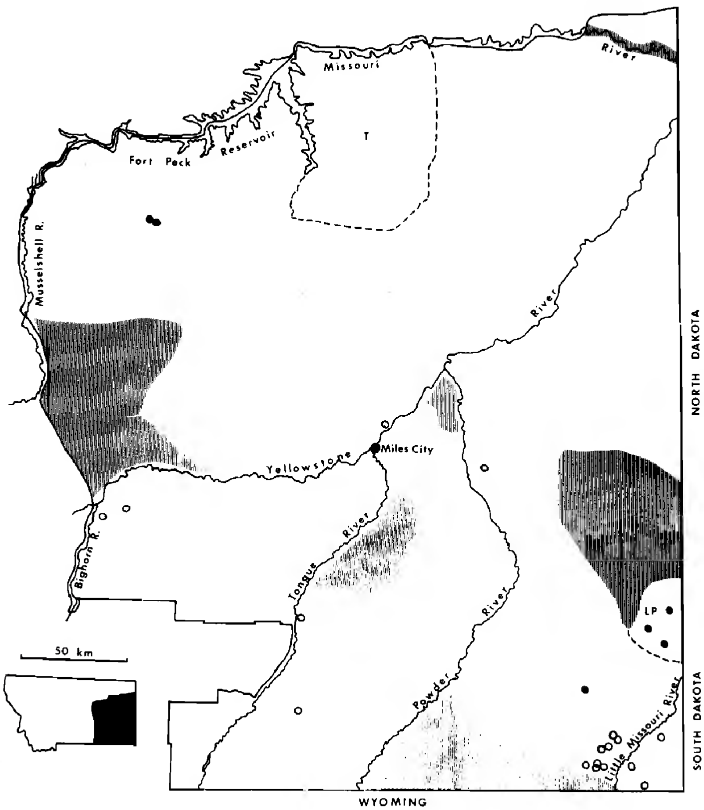

Figure 1. Map of the study area showing the distribution of Bald Eagles observed on the uplands closer than (open circles) or farther than (closed circles) 30 km from rivers. Shaded areas were not surveyed. Thompson's (1978) study area is identified by the "T" and the Long Pines Hills by the "LP". The map at the lower left shows the location of the study area in Montana.

Table 1. Wintering Bald Eagles observed in southeastern Montana during 1976-77, 1977-78 and 1978-79 in relation to rivers.

	Length of River Section (km)	Mean Annual Discharge (m^3/sec)	Number of Bald Eagles Observed: Along Rivers	Within 30 km of River	Over 30 km from River
Yellowstone River mouth of Bighorn River to North Dakota	475.6	369.9	22(10-30)[a]	2[b]	0
Missouri River[c] Ft. Peck Dam to the bridge at Wolf Point	109.6	303.3	2	0	0
Bighorn River Hardin to mouth	68.5	110.4	25(23-26)[a]	1	0
Powder River Wyoming to mouth	350.0	17.4	0	1	0
Tongue River Wyoming to mouth	326.5	12.1	5	2[d]	0
Musselshell River Mosby to mouth	96.5	7.5	0	0	0
Little Missouri River Alzada to S. Dakota	75.6	3.7	0	11	4[e]
Ft. Peck Reservoir mouth of the Musselshell River to Ft. Peck Dam	—	—	1	0	2
		TOTALS	55	17	6

[a]Mean (range) of counts during systematic flights in January 1977, 1978, 1979.
[b]Eagles wintering in prairie habitat unless otherwise noted
[c]From Thompson (1978)
[d]1 in pine habitat
[e]3 in pine habitat

summers, cold winters, and average annual precipitation between 300 and 400 mm. The major rivers of the study area, in decreasing order of mean annual discharge, are the Yellowstone, Missouri, Bighorn, Powder, Tongue, Musselshell, and Little Missouri (Table 1).

Methods

During the winters of 1976-77, 1977-78, and 1978-79, we recorded Bald Eagle observations incidental to aerial surveys for deer (*Odocoileus hemionus* and *O. virginianus*). Most of the study area was surveyed intensively by following drainage patterns in 150 hp Piper Super Cub airplanes. Surveys were conducted mostly during clear skies and with snow cover. About one-third of the upland area was censused each winter and no upland areas were resurveyed. A portion of the study area was surveyed aerially following parallel transects 1.6 km apart in winter 1977-78 as part of a separate study (Fig. 1) (Thompson 1978). Observations from the Long Pines Hills (Fig. 1) were based on ground surveys. All of the surveys were conducted between late December and the first

week of March; almost all were made in January and February. This corresponds with the period of fewest Bald Eagles on the Yellowstone River (Hinz 1977); thus, the birds encountered would probably be overwintering and not migrating. Some immature Bald Eagles may have been confused with Golden Eagles (*Aquila chrysaetos*), especially on the uplands, but immatures comprise a small proportion of the Bald Eagles along the Yellowstone River (Hinz 1977), and probably the rest of southeastern Montana, in January and February.

Bald Eagles along the Yellowstone and Bighorn Rivers were counted in conjunction with aerial waterfowl surveys in January 1977, 1978 and 1979. Waterfowl were counted first and eagles were counted on the return flight. A Piper Super Cub was also used for these surveys. The Yellowstone River was flown in two sections: one above and one below Miles City. The river flights required three days of flying and were conducted over as short a timespan as possible. An average of the three winter counts on the Yellowstone and Bighorn Rivers was used to compare with the upland survey, because the upland survey required three winters to complete. The "total count", therefore, included all Bald Eagles observed during the upland surveys plus the three-year average of the river surveys. The "total count" approximates the average number of Bald Eagles present each winter during the study period.

The Bald Eagles were divided into three groups: those observed along a river, those observed on uplands but within 30 km of a river, and those observed on uplands farther than 30 km from a river. Bald Eagles observed on the uplands were separated because Bald Eagles observed within 30 km of a river may have been visiting the river regularly. Swisher (1964) reported that Bald Eagles in Utah commuted 29 km from their feeding area at the Bear River Marsh to their roosting area. Lish (1973) observed a daily movement of 21 km by a Bald Eagle wintering in Oklahoma, and Southern (1964) found that eagles wintering along the Mississippi River usually ranged over a 5–6.5 km area, but occasionally flew over 50 km in one day.

Results and Discussion

A total of 71,500 km^2 was surveyed for Bald Eagles, including 1502 km of rivers. An average of 55 Bald Ealges (71% of the total for the study area) was observed along rivers, and a total of 23 (29%) was recorded on the uplands (Table 1), primarily near rivers (Fig. 1).

The Yellowstone and Bighorn Rivers comprised the most important wintering area; an average of 47 Bald Eagles (60% of the total for the study area) wintered there (Table 1). On the Yellowstone River, Bald Eagles were more concentrated in the upstream portion of the river because of more open water and waterfowl there (Hinz 1977). Bald Eagles were more concentrated on the Bighorn River, compared with the Yellowstone (Table 1), probably because it does not freeze completely in winter due to the warm water released from Yellowtail Reservoir. On 21 February 1978, when much of the Yellowstone River in the study area was frozen, 44 Bald Eagles were observed on the portion of the Bighorn River within the study area.

Seventeen eagles (22% of the total) were observed on uplands within 30 km of a river, ranging from 0.8 to 15.3 km and averaging 7.2 km (Table 1, Fig. 1). Hinz (1977) observed that Bald Eagles wintering on the Yellowstone River on this study area occasionally hunted over sagebrush-grasslands near the river and roosted at night in streamside cottonwoods. Roosting areas are important for wintering Bald Eagles (Murphy 1978)

and stands of cottonwoods, which could be used for roosting, are common along the rivers in the study area. Eagles observed on the uplands within 30 km of rivers may have roosted along the rivers at night and foraged there at other times. This group, which comprised about three-fourths of the eagles observed on the uplands, may therefore have been associated with both terrestrial and aquatic ecosystems. Upland wintering appeared to be proportionately more common near the smaller rivers than the three largest rivers, where more open water would probably be available (Table 1). This suggests that the Bald Eagles along the smaller rivers utilized terrestrial food sources when the rivers were frozen.

The only important upland/riparian wintering area located during our surveys was in the Little Missouri River drainage where 11 Bald Eagles were observed on a 500 km^2 area (Fig. 1). The eagles were observed there between 31 January and 6 February during the severe winter of 1978–79, when the river was completely frozen. At least half of the eagles observed were on carcasses of pronghorn antelope (*Antilocapra americana*). High winter mortality of antelope occurred throughout the study area, so the concentration of Bald Eagles was not due to a concentration of antelope carcasses. Bald Eagles have been seen regularly in the Little Missouri area in other winters including the winter of 1948–49 (Thompson 1949), indicating that it is a traditional wintering area. On 16 February 1980, during an unusually mild winter, three Bald Eagles were observed during an aerial survey on a small portion of this area, one of which was on the Little Missouri River. The Little Missouri area also supported the most dense wintering Golden Eagle population encountered during our surveys: 71 were observed on 2,976 km^2 (23.0 per 1,000 km^2). Platt (1976) indicated that Bald Eagles scavenged from Goldens on an upland wintering area in Utah.

The most important upland wintering area farther than 30 km from a river was the Long Pines Hills in the southeastern portion of the study area (Fig. 1), where a few Bald Eagles winter each year (G. Dusek and J. Ramsey, pers. comm.). This 600 km^2 area was not surveyed aerially for eagles, but an estimated three adult Bald Eagles wintered there in 1976–77, based on ground surveys associated with a white-tailed deer research project (T. Komberec and G. Dusek, pers. comm.).

The remaining three Bald Eagles on upland areas farther than 30 km from rivers were found on creeks with cottonwoods present. One of these eagles was probably associated with the Little Missouri River wintering area (Fig. 1).

The results suggest that relatively few Bald Eagles winter in southeastern Montana. Most winter on the major rivers, some are associated with rivers and upland areas, and a very few winter strictly on upland sites (Table 1). Observations made during our other field activities support this conclusion. This situation is similar to that found in Oklahoma, near the southern limit of the winter range of the Bald Eagle on the Great Plains (Steenhof 1978). There, upland wintering was limited to a few localities, and eagles concentrated on the largest rivers and reservoirs (Lish and Lewis 1975). However, the findings from Montana and Oklahoma contrast with the situation in Wyoming, Colorado, and Utah (Table 2) where Bald Eagles are more common on the uplands. Data from our study cannot be considered a true census and are, therefore, not completely comparable with the other data presented in Table 2. However, differences between our area and the other areas are large enough that we conclude they are real. Bald Eagles at the northern and southern limits of their winter range on the Great Plains apparently do not utilize upland areas to the same extent as they do in the central portions. This is also

Table 2. Use of uplands by wintering Bald Eagles in several study areas in the western United States.

Area	Size of Survey Area (km^2)	Density of Eagles on the Uplands (eagles/1,000 km^2)	Percentage of Eagles Observed on the Uplands	Source
Utah	923	124.6	100	Woffinden & Murphy 1977
Wyoming 1972	202,000	1.8	86[a]	Wrakestraw 1972
Wyoming 1973	202,000	2.7	89[a]	Wrakestraw 1973
SE Colorado 1967	57,000	0.3–0.7[b]	100	Enderson et al. 1970
SE Colorado 1968	57,000	0.8–1.6[b,c]	100[c]	Enderson et al. 1970
SE Montana	71,500	0.3	29	This study

[a]Calculated as the projected number of eagles on the uplands divided by the projected total number of eagles, which was the sum of the projected upland population plus the river counts. Upland transects did not cross the rivers (Wrakestraw 1972).

[b]The lower density represents the number seen from transect flights 1.6 km apart, the higher density is based on an assumption that the effective counting distance from the airplane was 0.4 km (Wrakestraw 1972). These are absolute minimum estimates, because only adult Bald Eagles were counted (Enderson et al. 1970).

[c]26 of 46 Bald Eagles observed were at a small stream, which was considered upland.

suggested by the observations that upland wintering was most common in the southern portions of our study area (Fig. 1) and the northern portions of Oklahoma (Lish and Lewis 1975). This may be related to the preference for Bald Eagles in the western United States to winter in areas with a normal weekly temperature of –4° to –1°C in late December with densities apparently declining progressively with warmer or colder average temperatures (Gerrard 1977). Perhaps greater competition for wintering areas along rivers has caused more Bald Eagles in the central Great Plains to winter on the uplands compared with farther north or south, where densities are apparently less (Table 2).

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FERRUGINOUS HAWK USING ROCK IN NEST DEFENSE

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While studying Ferruginous Hawks (*Buteo regalis*) in Harding County, South Dakota during 1977 I observed a resident female Ferruginous Hawk use a rock in nest defense. The incident occurred on 17 June, during one of my twice-weekly, post hatching nest visits.

As I approached the nest, the female flew overhead and circled, calling repeatedly. She showed no other aggressive behavior at this time. Her mate, responding to the calls, flew to the area of the nest and on 4 occasions swooped to within 3 m of me from a height of approximately 20 m. He then joined the female, circling and calling overhead. This pattern of nest defense, involving an aggressive male and more passive female, was typical of Ferruginous Hawks during the study. After 3 minutes of circling the female flew off in a southwesterly direction and disappeared over a nearby hill. She returned approximately 2 minutes later, circled overhead a few times and swooped toward me, approaching to within 10 m. Upon turning up from her dive she released a 5x7x10 cm stone which she carried in her talons. The stone landed within 5 m of me. The female then rejoined her mate overhead, both birds circling and calling until I left the area of the nest.

This behavior was not repeated during any of my 5 subsequent visits to this particular nest, nor was it exhibited by any of the other 34 breeding pairs of Ferruginous Hawks studied over a 2 year period. Janes (Condor 78:409, 1976) reported on a pair Common Ravens (*Corvus corax*) apparently using rocks during nest defense. To my knowledge, no other example of a raptor using rocks in defense of its nest has been reported.

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CHANGE IN RAPTOR HUNTING BEHAVIOR FOLLOWING HEAVY SNOWFALL

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Newton (1979, Population ecology of raptors, Buteo Books, Vermillion, South Dakota) discusses the strong relationship between raptor distribution and food resources. Dispersion patterns during the breeding season are often linked with the distribution of food in an area. Although data are limited, a similar relationship between food availability and raptor densities has been assumed in winter populations (Newton 1979). This note reports observations of raptor response to a sudden change in food distribution and abundance caused by a heavy snowfall.

Observations were made in Columbia Basin shrub-steppe habitat in Morrow County, Oregon, near the town of Boardman. Natural vegetation in this area was represented by big sagebrush (*Artemisia tridentata*) and rabbitbrush (*Chrysothamnus* spp.)/cheatgrass (*Bromus tectorum*)/needle-and-thread grass (*Stipa comata*) habitat types. Dominant winter raptor species in the area included Rough-legged Hawk (*Buteo lagopus*), Marsh Hawk (*Circus cyaneus*), and Short-eared Owl (*Asio flammeus*).

On 8 and 9 January 1980, a storm dropped 36 cm of snow in the Boardman area. The only open ground was that cleared by highway maintenance crews. On 9 January, during the second day of uninterrupted snowfall, a raptor survey was conducted along approximately 95 km of road. Three Rough-legged Hawks, 2 Marsh Hawks, 1 Short-eared Owl, and 1 Barn Owl (*Tyto alba*) were observed. All were perched next to or flying parallel to the road. Those observed along Interstate I-84 (Marsh Hawks, Short-eared Owl, Barn Owl) flew along the median divider of the freeway alternately searching west and east-bound lanes. The deep snow precluded acquisition of prey in traditional hunting areas (i.e., hunting over shrub-steppe habitat) and caused raptors to forage along cleared highways for road-kills and possibly for live prey. Road searching behavior in raptors continued for three additional days until normal hunting territories were partially cleared by rain. These observations provide evidence to a strong relationship between food resources and winter raptor distribution as well as a demonstrated ability of raptors to adapt to sudden changes in food distribution and abundance.

HARRIER PURSUING MINK

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I observed through binoculars, at a distance of approximately 30m, a female or immature Hen Harrier (*Circus cyaneus*) pursuing and apparently attempting to catch a mink (*Mustela vison*) along the main dike of the Horicon National Wildlife Refuge, Wisconsin, on 8 October 1977 at 13:30. The mink was running along the dike, with the harrier alternately soaring and hovering 2 to 3m overhead. The harrier dropped within a few cm of the mink and grasped at it with its talons, although it did not actually touch the mink. Each time the harrier dropped, the mink stopped, twisted its head over its shoulder at the harrier, and bared its teeth. The harrier then quickly rose 1 or 2m in the air, and the mink resumed running down the dike. These confrontations were repeated 4 times during a pursuit that covered approximately 100m and lasted approximately 3 min. After the fourth confrontation the harrier rose to a height of about 5m and flew away from the dike into the interior of the marsh. The mink continued running down the dike for approximately another 20m, then ran into the vegetation and disappeared.

The harrier, a comparatively light-bodied raptor, has long been known to feed almost exclusively on small mammals and small birds (McAttee 1935, Errington and Breckenridge 1936, Hecht 1951, Sherrod 1978). Harriers have been observed to follow predatory mammals, including red fox (*Vulpes vulpes*) (Bandy and Bandy 1978) and house cat (*Felis domesticus*) (Berger 1956). However, in neither of these cases did the harrier appear to be seriously attempting to catch the predator, nor did the predators show any aggressive behavior toward the harriers. Bandy and Bandy (op cit.) stated that the interaction which they observed with the fox may have been an example of cooperative hunting behavior.

It is likely that I observed the inquisitive behavior of an inexperienced young harrier toward a mink, or an innate following response in the harrier. However, the apparent aggressive behavior between the harrier and the mink suggests the possibility that the hawk was attempting to catch and kill the mink.

I thank R. A. McCabe and S. A. Temple for helpful comments on this manuscript.

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RED-SHOULDERED HAWKS WHIRLING WITH TALONS LOCKED IN CONFLICT.

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Whirling with talons locked has been described for eagles of the genus *Haliaeetus* and the Upland Buzzard (*Buteo hemilasius*) by Brown and Amadon (1968) and by Springer (1979) for a pair of Red-tailed Hawks (*Buteo jamaicensis*), as being aerial courtship. Both Brown and Amadon (1968) and Beebe (1974), however, caution that the whirling could, at times, be conflict rather than display. I here present an instance, observed by my wife and me at the Hendrie Ranch, 24 km south of Lake Placid, Florida, where the grappling was part of a conflict between the male of a breeding pair of Florida Red-shouldered Hawks (*Buteo lineatus alleni*) and a conspecific intruder. As far as I am aware, this is the first case of whirling described for *B. lineatus*.

We had been following the activities of a mated pair of Red-shouldered Hawks for 6 weeks when, at 1040 on 11 February 1981, I saw 3 Red-shouldered Hawks soaring over the woodland swamp at the edge of which the pair built a nest later in the month. One of the hawks lowered its talons as it dove on a second hawk and nearly struck it. It then rose and dove again. Next I saw 2 hawks interlocked and whirling toward the ground. At this moment my wife, who had been walking along another side of the swamp, saw the hawks dropping toward a spot in open pasture only 10 m from where she stood. Using 8 x 30 binoculars she could see that each was grasping one foot of the other, as with one leg free and wings partly spread they fell relatively slowly, as though some force were pulling them apart. When 10–15 cm above the ground, one shook its talons as if trying to get loose. The two then separated and rose upward, one pursuing the other in soaring flight to the east, well beyond the usual range of the pair. The female of the pair, meanwhile, landed in a leafless tree where her mate, returning from the pursuit, rejoined her 5 min later.

We identified the sexes on the basis of prior experience. We had noted from the beginning of observation 6 weeks before that one of the pair had notably redder underparts than the other. When the pair started copulating we were able to identify this bird as the male. The female was then identifiable by paler underparts, characteristic of the south Florida race (*B. l. alleni*) of Red-shouldered Hawks. She was also identifiable, at times, by her behavior. Thus on the last 2 of the 4 copulations which we witnessed, both on 9 February, she had given short cries before, during and for some time after copulating. On 11 February she gave the same cries in series of 3–5 every 15 to 20 sec during most of the 30 min she and her mate perched in the leafless tree. It seemed as though she were inviting him to copulate but he appeared to be uninterested.

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ABSTRACTS OF THESES AND DISSERTATIONS

THE NESTING BIOLOGY AND BEHAVIOR OF WOODLAND RAPTORS IN WESTERN MARYLAND

This thesis reports the composition and status of the raptor community in the central Appalachian eastern deciduous forests of western Maryland. In addition, the breeding chronology, behavior, and food habits of these raptor species are described.

Red-tailed (*Buteo jamaicensis*), Red-shouldered (*Buteo lineatus*), Broad-winged (*Buteo platypterus*), and Cooper's (*Accipiter cooperi*) Hawks nest in western Maryland. Forty-one breeding pairs of these raptor species were monitored during the 1978 and 1979 nesting seasons.

Broad-winged Hawks were the most successful species with 82.3% successful attempts. Cooper's Hawks were the next most successful at 66.6% followed by Red-shouldered Hawks at 62.5% and Red-tailed Hawks at 50.0%. Fledging rates for Broad-winged, Cooper's, Red-shouldered and Red-tailed Hawks were 1.7, 2.5, 1.8 and 1.5 per successful attempt, respectively. Although Broad-wings were the most successful nesters in this area, Cooper's Hawks had the greatest productivity per successful nest.

Nesting survival to fledging was 58.8% for the Cooper's Hawk, 68.9% for the Broad-winged Hawk, 60.0% for the Red-shouldered Hawk and 50.0% for the Red-tailed Hawk. Small mammals, particularly the eastern chipmunk (*Tamias striatus*), were the major prey item for Red-shouldered, Cooper's, and Broad-winged Hawks. Prey remains from Red-tailed nests were composed primarily of the eastern fox squirrel (*Sciurus niger*) and the eastern gray squirrel (*Sciurus carolinensis*).

Janik, Cynthia A. 1980. The nesting biology and behavior of woodland raptors in western Maryland. M.S. Thesis, Frostburg State College, Frostburg, Maryland.

NEST SITE SELECTION BY THE RED-SHOULDERED HAWK (*BUTEO LINEATUS*) IN SOUTHWESTERN QUEBEC

The patterns of nest site selection by the Red-shouldered Hawk (*Buteo lineatus*) were studied in 1978 and 1979 at two areas in southwestern Québec in order to investigate the potential effects of this behavior on reproductive success. Hawks arrived in the main study area (Vaudreuil County) by late March and began nesting activities almost immediately. A comparison of thirty nest sites and twenty-five randomly located control sites in that area indicated that there were significant ($p<0.05$) differences in several habitat features between the two groups. The nests of the Red-shouldered Hawk were typically

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located in the most mature sugar maple (*Acer saccharum*) or beech (*Fagus grandifolia*) stands available. The nests were usually located in multibranch forks in the middle of the forest canopy, at about half of the total height ($\bar{x} = 49\%$) of the large nest trees, probably providing protection for incubating adults and nestlings from predation and adverse environmental conditions. There is evidence that some nesting pairs may be able to tolerate considerable human activity in the immediate vicinity of their nests. A variety of discriminant analyses were used to identify the habitat features which contributed most to the significant ($p < 0.05$) separation of the nest sites from the control sites. Principal components analyses demonstrated that suitable Red-shouldered Hawk nesting habitat, as defined by the nest sites, comprises a recognizable subsection of the available forest habitat in the main study area. The possible implications of these findings on the behavioral mechanisms of nesting habitat selection by the Red-shouldered Hawk are discussed.

Morris, Michael M. J. 1980. Nest site selection by the Red-shouldered hawk (*Buteo lineatus*) in southwestern Québec. M. Sc. Thesis, McGill University, Montréal, Québec, Canada. 57 pp.

NEST SITE HABITAT SELECTION BY WOODLAND HAWKS IN THE CENTRAL APPALACHIANS

Four diurnal woodland raptor species (Broad-winged Hawk, *Buteo platypterus*, Red-shouldered Hawk, *B. lineatus*, Red-tailed Hawk, *B. jamaicensis*, and Cooper's Hawk, *Accipiter cooperii*) are present in the central Appalachians but no quantitative studies of their nest site habitat have been conducted. By measuring a variety of habitat variables associated with each nest site and also at random points in the forest an assessment of the nest sites selected by each species was made, along with interspecific differences.

Using analysis of variance and stepwise discriminant function analysis, potentially important habitat characteristics were identified for each species. White oak (*Quercus alba*) was the most common nest tree. Distance to water, percent nest height, distance to the nearest forest opening, basal area and dbh of the nest tree were important discriminating variables among the four hawk species. Compared with the available forest area as described by random sampling, Broad-winged Hawks were found nesting close to water and to forest openings and in areas with a high site index. Red-shouldered Hawks consistently nested very near to water and in very large trees contained within stands of mature forests. Red-tailed Hawks nested higher in trees than any of the other species, on or near the tops of ridges, placing their nest sites far from water and forest openings. Cooper's Hawks nested proportionally higher in trees than the Broad-winged and Red-shouldered Hawks. They were associated with semimature forest with a well developed understory and ground cover layer. The disciminant function analyses revealed that each species appears to select rather specific nesting areas both in terms of the proximity of the site to various physiographic features and in terms of the nest tree itself.

Titus, Kimberly. 1980. Nest site habitat selection by woodland hawks in the central Appalachians. M.S. Thesis, Frostburg State College, Frostburg, Maryland.

BOOK REVIEWS

A Guide to Hawk Watching in North America. 1979. Donald S. Heintzelman. Pennsylvania State University Press. 284 pp. $12.95 cloth bound, $6.95 paper bound.

The advertising brochure from Penn State Press states that until the arrival of Donald Heintzelman's book, *A Field Guide to Hawk Watching in North America,* ornithologists and bird watchers with a particular interest in North American hawks have had to do without a useful field guide. This statement is largely accurate. Other birding field guides, including Roger Peterson's and the Golden Series guide to birds of North America, have been available with good plates facilitating hawk identification, but no book until Heintzelman's has devoted itself entirely to North American hawks. In many ways it is after the mold of the book, *Flight Identification of European Raptors* by Porter, et al.

The basic approach of this book is to give the reader a written sketch of plumage characteristics concerning a given species, its range of distribution, and the location of useful hawk observation posts across the U.S. and Canada. A rough outline of a species life history (i.e., descriptions of nest, clutch size, incubation period, etc.) is included as well, but as is the case in most field guides, no major references are cited giving the source for specific life history information. The nucleus of the book is the series of approximately 184 identification plates. Most of these are photos while a few are drawings. The plates include pictures of hawks in various phases of plumage and action positions—many in flight and some at nests. Although well focussed photos of raptors in flight are not easily obtained, Heintzelman, with a few exceptions, presents a good collection from assorted photographers. Occasional drawings, such as the one depicting the two color phases of the Ferruginous Hawk (*Buteo regalis*) (p. 118), are poor. There are good photographs available for this species. The photo of the Hook-billed Kite is of questionable value; it certainly won't help anyone identify this species. Additionally, some drawings are simply copies from other well-known raptor works. The sketch of an immature Gray Hawk (*Buteo nitidus*) for example, is taken from Brown and Amadon's classic work, *Eagles, Hawks and Falcons of the World,* while the sketch of the adult was taken from May's *The Hawks of North America.* While Heintzelman does acknowledge books, it seems as though the credit for these drawings is not given to the original artists nor even to the book from which they came, but rather to the artist who copied them. Nevertheless, on the whole, the plates are good and refreshingly free of birds with jesses around their tarsi.

Heintzelman's book is geared principally to hawk watching at times of migration and does not dwell on behaviors concerning the breeding season. There are figures showing how migration hawks use thermals along ridges, selected maps of bird refuges, and a figure showing when major movements of 14–17 species of raptors occur in eastern and western North America. The book has four appendices. The first gives accidental North American raptor sightings, including such notables as the Neotropical Roadside Hawk (*Buteo magnirostris*) and old world Kestrel (*Falco tinnunculus*). The second appendix gives a list of hawks known to occur in the Hawaiian Islands, while the third lists North American Raptor Conservation Organizations. The fourth appendix consists of data sheets useful for recording information during hawk flights.

A Guide to Hawk Watching in North America will probably be most attractive to

nonprofessionals that have an especially difficult time identifying North American hawks. The item of most use to experienced field biologists may be the list and brief description of well-used hawk migration sites in regions unfamiliar to them.

W. J. Mader

The Study of Raptor Populations. Donald R. Johnson. The University Press of Idaho, Moscow, Idaho 83843, 2nd ed, 1981. 80 pages, $6.95.

This is Don Johnson's second edition of his useful little booklet. The first edition was in offset format on 8½ × 11 paper, this one is typeset and of a smaller size, 5½ × 8½. Don revised his first edition after the appearance of Newton's *Population Ecology of Raptors* and has thus been able to take advantage of some of Newton's information, references, etc. The booklet contains the following chapters: Identification, Census Techniques, Productivity, Survival, Mortality, Food, Prey Base Studies, Niche Relationships, Energetics, Migration, Sexual Dimorphism and Raptors as Predators. The layout of the chapters can be represented by chapter 3 on Productivity and has the following subtitles: Clutch Size, Brood Size, Fledgling Success, Other Related Parameters and Reproductive Strategies. Each chapter is only 4–5 pages long including the literature cited. Here Don has tried to sift through the literature and present enough to give the reader a good idea of the topic. For example, his chapter 3 contains 62 references. Some of the shorter chapters, such as Sexual Dimorphism, has only 14 references. The book treats both hawks and owls with emphasis mainly on North American forms. The concept of the booklet, as I see it, is to provide those interested in raptors, but not necessarily knowledgeable of them, a handy and ready reference. I have also found it very useful to give me a quick review of the "meat" of the subject. To be sure, there are many good references not included but on balance the booklet serves a useful purpose and for the nominal price, I heartedly recommend it.

Clayton M. White

REQUEST FOR ASSISTANCE

An *ANNOTATED BIBLIOGRAPHY* on raptors in Alaska and adjacent portions of western Canada (Yukon Territories and western British Columbia) is being prepared for the U.S. Fish and Wildlife Service by Alaska Biological Research. References, reprints, or unpublished articles dealing with any aspects of raptor ecology in these geographic areas (e.g. distribution, food habits, productivity) would be appreciated.

At the same time the USFWS is developing a *MAILING LIST* of knowledgeable sources and parties interested in raptors in these areas. If you are interested in being put on this mailing list or have reference material for the bibliography, please write to:

BOB RITCHIE
ALASKA BIOLOGICAL RESEARCH
P.O. Box 81934
FAIRBANKS, AK 99708

NEWS RELEASE FOR THE INTERNATIONAL OSPREY FOUNDATION, INC.

A new organization, *The International Osprey Foundation, Inc.*, has been formed to study the problems of restoring Osprey numbers to a stable population, make recommendations to enhance the continued survival of the Osprey, and initiate educational programs. The objectives of TIOF are:

1. To promote the study and preservation of the Osprey, *Pandion haliaetus,* and other raptors throughout the world.
2. To establish and maintain lines of communication between those studying Ospreys whether on an amateur or professional level.
3. To create a working bibliography on Ospreys.
4. To develop a program of public education publicizing the ecology and status of Ospreys.

TIOF is based on Sanibel Island, Florida and monitors the thirty-odd Osprey nests on the island. Recently, it has also taken over responsibility for an ongoing artificial nesting program which The Fund for Animals, Inc. established on the island in 1976.

Internationally, TIOF is in the process of creating a computerized list of Osprey researchers by way of registration cards which will help to form a better line of communication between those doing similar research throughout the world. Another major project is the creation of a working bibliography on Ospreys which will be similar to the one produced on Bald Eagles by Lincer, et al, 1979.

Membership in TIOF, a non-profit organization, is open to anyone with an interest in Ospreys. Membership categories are:

1. Individual/$10
2. Family/$15
3. Sustaining/$25
4. Supporting/$50
5. Contributing/$100
6. Donor/$250
7. Life/$500
8. Student/(To undergrad level) $8

Membership checks or request for registration cards should be sent to:

Mark A. Westall, President
TIOF
289 Southwinds
Sanibel, Florida 33957